

Preface

The goal of this book is to develop a methodology for enhancing fracture detection and correctly delineating reservoirs with fractures. From the rock mechanics to seismic forward modeling then AVO inversion, the book deeply explores the mechanical formation of fractures and fractured media and presents an enhanced fracture detection technique that uses a new finite-difference scheme to accurately model fractures and analyze the fracture response in seismic traveltime and amplitude, and then develops a method for accurate reservoir delineation by deriving new AVO fracture equations to correctly estimate the properties of the fractured medium, the host medium, and the fractured medium with impedance contrast.

With the long wavelength assumption, a linear slip interface is equivalent to a fracture interface that satisfies the nonwelded contact boundary conditions. Therefore, the fractured medium can be regarded as a combination of a fracture, or a set of fractures, and a host medium as a horizontally fractured medium is composed of a horizontal fracture embedded into a homogeneous isotropic host medium; and a vertically fractured medium is formed by inserting a vertical fracture into a homogeneous isotropic host medium; an orthogonally fractured medium is assembled from a vertical fracture and a homogeneous VTI host medium, or a horizontal fracture and a homogeneous HTI host medium, or two orthorhombic fractures and a homogeneous isotropic host medium. Theoretically, the composed fractured media are effectively equal to the transversely isotropic medium with a symmetric axis (TI) media.

New finite-difference schemes with imposed explicit boundary conditions for horizontal, vertical, and orthorhombic fractures are implemented to generate seismograms that precisely illustrate the fracture representations in seismic data. The results indicate that the fractures are detectable, even though the fractured medium does not have impedance contrasts, and that the fractured medium can be characterized as a transversely isotropic medium. An analysis of how fractures are represented in seismic data can help in fracture detection in geoscience.

New exact equations for the reflection and transmission coefficients of a fractured medium with impedance contrast and new approximate AVO equations

including fracture parameters are derived. This provides a way to separate the surface seismic records into the fracture reflections and reflections of the impedance contrast. Therefore, the fracture, the host medium, and the fractured medium with impedance contrast properties can be estimated from seismic data to correctly delineate the reservoir characterization.

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